CONCLUSION AND FUTURE SCOPE

Physical layer design is a very important part of the communication system and has a profound impact on the feasibility of the communication processes at the higher layers. OFDM-based transmission is a promising candidate to achieve high data rates via collective usage of a large number of subcarrier bands. This modulation technique allows digital data to be transmitted over a radio channel by using a large number of narrow bandwidth subcarriers and offer several advantages over other transmission technologies such as high spectral efficiency, robustness to fading channel, immunity to impulse interference, and capability of handling very strong multi-path fading and frequency selective fading without having to provide powerful channel equalization. However, one of the major disadvantages of OFDM communication is its sensitivity against carrier frequency offset, which causes inter-carrier interference and degrades the performance of the system. The carrier frequency offset is caused by the mismatch of frequencies between the oscillators of transmitter and receiver, or by the Doppler spread due to the relative movement between the transmitter and receiver as well as phase noise arises predominantly due to imperfections of the local oscillator in the transceiver. However, the ICI induced by phase noise and timing offset can be completely compensated or corrected. Since the Doppler spread or frequency shift is random, so we can only mitigate its impact in the system. A simple and most effective method, which is known as self-cancellation scheme, reduces the ICI at the cost of transmission rate with little additional computational complexity.

In this thesis, we have investigated an efficient ICI cancellation technique and developed a novel mathematical model to improve the bit-error-rate and carrier-to-interference ratio compared to the other techniques as reported in literature. In the proposed OFDM system, at the transmitter, IFFT is performed for first part of the data and FFT for the second part of data. At the receiver, FFT is performed for first part of the data and IFFT for the second part of data. These combined operation forms an ICI cancellation scheme for the OFDM system. We analyze the subcarrier index before
and after cancellation of the frequency offset and discuss the carrier-to-interference ratio. The average carrier-to-interference power ratio is used as the ICI level indicator and theoretically carrier-to-interference ratio expression is derived for the proposed scheme. The proposed scheme provides significant carrier-to-interference ratio improvement, which has been studied theoretically and supported by simulations.

A repeated correlative coding scheme is also proposed to combat ICI caused by the frequency offset in OFDM communication systems. This proposed scheme combine two ideas of the well-known methods, which are the coding of adjacent subcarriers with antipodal of the same data symbol (ICI self-cancellation) and correlative coding. A mathematical expression for the carrier-to-interference ratio by using this proposed repeated correlative coding scheme is derived. The carrier-to-interference ratio for proposed scheme is significantly improved compared to the correlative coding as well as self-cancellation scheme. The bit-error-rate of proposed scheme is also compared with the ICI self-cancellation scheme and correlative coding scheme, which is comparable to that of the ICI self-cancellation scheme and much better than correlative coding scheme. The proposed theoretical analysis and simulation results prove that the ICI caused by multicarrier frequency offset can be cancelled efficiently by using the proposed repeated correlative coding scheme for the OFDM communication system. However, to statistically model the wireless channels, it is a very common practice to consider two independent propagation models, the small-scale propagation model for random amplitude and phase variations and large-scale propagation model for power (shadowing and path loss) variation. Several distributions have been discussed to model the small-scale fading such as the Rayleigh, Rician and Nakagami-m in detail. The Rayleigh and Rician distributions are used to characterize the channel envelop of faded signal over small geographical areas or short term fades.

Recently, the Nakagami-m fading channel model has received considerable attention due to its great flexibility and accuracy. In studying the performance of wireless communication system, it is usually assumed that two signals are independent of one another, however, there are number of real-life scenario in which this assumption is not valid. Therefore, the effect of correlated fading on the performance of a diversity combining receiver has received a great deal of research
interest. We have analyzed the performance of correlated Nakagami-m fading channel by using the maximal-ratio combining diversity at the receiver. A closed-form mathematical expression is derived for the average bit-error-rate, symbol-error-rate and outage probability for various modulation scheme in terms of the higher transcendental function such as Appell hypergeometric function by using the well-known moment generating function based approach with arbitrary fading index for OFDM communication systems. The diversity path greater than two (M ≥ 2) at the receiver hence the average bit-error-rate performance of the OFDM system is improved significantly. The proposed mathematical analysis is used to study various novel performance evaluation results with parameters of interest such as fading severity and correlation coefficients, which is very significant for the design consideration of the OFDM communication systems.

In the wireless communication systems, the multipath fading of the signal is important phenomena, which limits the channel capacity. We have investigated the marginal moment generating function (MMGF) for the correlated Nakagami-m fading channel by using maximal-ratio combining diversity scheme at receiver for the computation of the channel capacity for various adaptive transmission schemes such as: 1) optimal simultaneous power and rate adaptation, 2) optimal rate adaptation with constant transmit power, 3) channel inversion with fixed rate, and 4) truncated channel inversion with fixed rate. An analytical expression for the channel capacity as a function of signal-to-noise ratio over the correlated Nakagami-m fading channel with maximal-ratio combining diversity at the receiver is obtained, which is valid for arbitrary value of the fading parameters. We have also analyzed the effect of correlation on the channel capacity. Due to their simple forms, these results offer a useful analytical tool for the accurate performance evaluation of the various communication systems of practical interest. In addition to multipath fading, the quality of signal in the wireless communication environment is also affected due to shadowing from various obstacles in propagation path. The Nakagami-m and Rayleigh-lognormal (Suzuki) are well known composite statistical distribution to model the multipath fading and shadowing. The Gamma probability density function (PDF) was proposed for shadowing instead of the lognormal and the resultant PDF is called generalized-K distribution for the shadowed fading channel and the $K$-
distribution when the short term fading is modeled by using the Rayleigh instead of the Nakagami-m PDF. The K-distribution is derived as a special case of the generalized-K distribution by letting $m = 1$. The generalized-K distribution fading model characterizes the confined effect of fast and slow fading in the received signal by using two shaping parameters.

We have also investigated a simple and novel MMGF based channel capacity analysis approach over generalized-K fading channel with maximal-ratio combining diversity. Initially, an analytical expression for the MMGF of received signal-to-noise ratio with M-branch maximal-ratio combining diversity is obtained and utilizes it to derive the mathematical expression for the channel capacity under the different power and rate adaptation policies for arbitrary value of shaping parameters. The result of proposed methods is compared with other reported literature to support the analysis. We have derived the expression for the channel capacity with optimal rate adaptation ($C_{ORA}$) which is valid for arbitrary values of the shaping parameters $k$ and $m$. Moreover, we derived an expression for the capacity for channel inversion with fixed rate ($C_{CIFR}$). The $C_{ORA}$ and $C_{CIFR}$ are very easily computed by using the MGF based approach. We also derived the marginal MGF based channel capacity for truncated channel inversion with fixed rate ($C_{TIFR}$) and channel capacity for optimal rate and power adaptation ($C_{OPA}$) schemes for the Generalized-K fading channel, which is a simple and novel approach that can be applied to other fading channels also.

Multicarrier techniques, such as OFDM support huge data rates that are robust to channel impairments. However, with a growing demand for spectrum access, it may be difficult for any single transmission to obtain a large contiguous frequency spectrum block in dynamic spectrum access environment. Spectrum management is further complicated when considering worldwide operations. Moreover, there might be measurement-based controls on the spectrum usage, such as temporal, spectral, or energy characteristics, that would constrain the availability of the contiguous frequencies. Currently, spectrum allotment operates by providing each new service with its own fixed frequency block. Demand for access to spectrum has been growing dramatically, and is likely to continue to grow in the foreseeable future. OFDM-based transmission is a promising candidate for a flexible spectrum pooling system in dynamic spectrum access environment, where the implementation achieves high data
rates via collective usage of a large number of subcarrier bands. This modulation technique allows digital data to be transmitted over a radio channel by using a large number of narrow bandwidth subcarriers. Usually, these subcarriers are regularly spaced in frequency, forming a contiguous block of spectrum. Moreover, it is possible to turn-off subcarriers corresponding to the spectrum occupied by the incumbent users in order to avoid any interference to existing transmissions, thereby enabling secondary utilization of the unused portions of the spectrum to improve the spectrum utilization efficiency as well as mitigate apparent spectrum scarcity problem. The growing interest of studying OFDM-based cognitive radios is due to the apparent scarcity of the large spectral bandwidth for high data rate communications. OFDM based cognitive radios can handle this apparent spectrum scarcity and enable high data rate communications utilizing aggregate non-contiguous bands of spectrum.